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What next for Mars?

Future missions to the red planet require coordination — and a keen eye on costs.

The story of the Phoenix Mars lander (see page 690) raises nagging questions about how to study Earth's most interesting neighbour. Mars has been visited by spacecraft more often than any other planet. Yet the frequency of the probes has made them no cheaper. The Phoenix mission, a bargain by NASA standards, cost more than US$400 million — almost half the annual budget of the US Geological Survey that studies Earth's terrain. NASA's next planned mission to the Martian surface, a rover known as the Mars Science Laboratory (MSL), has a budget that was pushing $2 billion even before last week's announcement that its launch date was to be delayed by two years; it will now comfortably exceed that sum.

Granted, investment on this scale has produced stunning science. Mars has been mapped from orbit in exquisite detail. The remarkably long-lived Spirit and Opportunity rover missions, which landed five years ago next month, have produced a rich scientific understanding of the surface. And Phoenix itself has revealed a polar environment more dynamic than anything yet seen on the planet, with frosts coming and going, clouds dropping gentle snows and subsurface ice vanishing into vapour.

What this huge investment has not produced, however, is the long-term infrastructure and reusable technology that would make future missions more affordable. To take one example: the most difficult part of any mission to the Martian surface is landing, yet every such mission to date has used technology tailored from scratch. There are currently no plans to reuse the rocket landing system painstakingly developed for Phoenix mission, nor the air bags of the rover missions, nor even the ambitious 'sky crane' system that will supposedly lower MSL to the surface from a kind of rocket-powered hovercraft.

This constant reinvention is an indulgence that planetary exploration programmes can no longer afford. The United States and Europe, which have so far led the way in Mars exploration, should also lead the way in this respect by jointly reusing technology wherever it is remotely feasible. Rather than developing a new parachute-braking system, for example, the ExoMars rover being planned by the European Space Agency (ESA) could commit to using the air-bag technology deployed by NASA's rovers, and use as many of the other components from those missions as possible.

Looking further ahead, NASA, ESA and perhaps the new spacefaring nations in Asia should jointly start developing standard technologies for Mars exploration. One example might be a landing system designed to deliver hardy sensors to the surface at high speed, allowing the piecemeal, pay-as-you-go deployment of a planet-wide network to monitor Mars's meteorology and seismology. Another might be a shared, long-lived communications infrastructure: satellites in orbit around Mars with large antennas pointed towards Earth that are designed to relay even weak signals from the various science payloads. Such a system would mean that payloads could be built much more cheaply.

Meanwhile, the most effective way to improve the returns on Mars exploration would be better cost discipline. Missions understandably go over budget. There is always pressure to include more instruments, not least because researchers are aware of how few opportunities there are. And the incentives to be realistic in initial budgeting are relatively small, as the missions are unlikely to be cancelled if the costs escalate.

Cancelling, or radically downscaling, overbudget missions such as MSL would set science back in the short term. It would also be difficult politically, as aerospace contractors and NASA's spacecraft-building centres have a lot of clout. But the only way to make Mars exploration a more regular affair is to stop the missions from costing too much. Eventually, a virtuous circle could be established: cheaper missions would mean more of them, which would mean less pressure to overload each one, in turn keeping the costs down. The fact that a series of failures followed an attempt to do this in the 1990s does not mean it was the wrong thing to do; it means that the effort needs clearer management and accountability, technology that can be reused from mission to mission and patience.

The hard truth is that trying to understand one planet from the surface of another is going to be a long, drawn-out affair. The early history of the space age, in which ancient points of light turned overnight into worlds as complex as our own — accompanied by detailed and often spectacular images — promised an unsustainable pace of progress. The progress of planetary science now demands time and a sound strategy. ■

Watching Big Brother

The world is sleepwalking into a surveillance society. A European court ruling offers a timely wake-up call.

The European Court of Human Rights last week issued an opinion to which the developers and users of new technologies should pay heed. "Any state claiming a pioneer role in the development of new technologies," the court said, bears special responsibility for "carefully balancing the potential benefits of the extensive use of such techniques against important private-life interests."

This timely reminder, coming just before the 60th anniversary on 10 December of the Universal Declaration of Human Rights, was a strike at the British government's policy of keeping DNA fingerprint records on an ever-growing number of innocent people in England and Wales. That policy was indeed pioneering: the United Kingdom authorized the world's first national DNA database in 1994. The database has since proved helpful in solving a small but significant number of crimes, and many countries have followed suit. But the system, originally intended to cover only people convicted of serious offences such as murder and rape, has expanded to include samples from anyone arrested for any recordable offence — even dropping litter — and to keep them on record even if the arrest does not lead to a conviction. Moreover, the data have been used not just to match individuals to crimes, as originally intended, but also for more dubious applications such as searching for a perpetrator's blood relatives (see *Nature* **449,** 377–378; 2007).

As a result, Britain's DNA database has grown to become proportionally the largest in the world; it contains samples and data for 7% of UK citizens, far ahead of Austria in second place with 1%. The European Court's decision thus paves the way for 850,000 people, including tens of thousands of children, to have their records removed.

DNA databases are but one small tip of the emerging surveillance society. Even leaving aside law-enforcement and security initiatives, vast amounts of data are being collected by private firms through citizens' use of credit cards, mobile telephones and electronic travel tickets, not to mention the Internet and e-mail. These data are typically gathered not for any sinister purpose, but as legitimate efforts to offer customers better service. But the databases exist. And without strong safeguards, they could slowly and steadily be linked into an all-pervasive monitoring system that would make George Orwell's concept of 1984 look technologically tame — all in the name of security, efficiency and convenience.

Such concerns are certainly not new; Orwell's book was published in 1949. But the dizzying pace of technological advance makes them ever more salient — even as it makes the world's multitude of existing privacy acts seem light-years behind. Scientists, in particular, have an ongoing responsibility to reflect on the human-rights issues raised by the technologies they develop, and to lobby for appropriate oversight and controls. The risks posed by overzealous surveillance (see page 680) and the associated technologies are topics that should be addressed by the American Association for the Advancement of Science's Science and Human Rights Coalition, a forum of scientific bodies and human-rights groups to be created in January 2009 (see *Nature* **456,** 2; 2008).

"Without strong safeguards, databases could slowly and steadily be linked into an all-pervasive monitoring system."

Technology can be a powerful force for human rights. Earth-observation satellites, for example, have provided evidence on conflicts and ethnic atrocities in areas where journalists are banned. And DNA fingerprinting has resulted in the freeing of wrongly convicted individuals, a role exemplified by the US Innocence Project in New York. The idea that the identity of a human can be revealed from samples of any cell in his or her body is a symbol of the fact that every person is unique. The declaration of human rights asks us to treasure and honour all these unique individuals with respect for their autonomy — not to simply look for better ways to barcode them. ■

Failure in the field

The US military's human-terrain programme needs to be brought to a swift close.

The US Department of Defense's Human Terrain System, an attempt to have social sciences inform military decision-making, is failing on every level.

In theory, it is a good idea. The Human Terrain System aims to embed anthropologists and other social scientists in military units in Iraq and Afghanistan to help improve understanding of local cultures and thus relieve tensions between civilians and soldiers. In practice, however, it has been a disaster. Questions have been raised about how well the programme vets its employees (see *Nature* **455,** 583–585; 2008). Some scientists who have joined the system have complained about inadequate training. And qualified researchers have been dismissed for seemingly trivial reasons, even though much more questionable people seem to breeze onto the payroll.

A case in point is Issan Hamama. Under investigation by the Federal Bureau of Investigation since 2003 as a possible former spy for Saddam Hussein, Hamama nonetheless managed to secure a job as a translator for the Human Terrain System. Late last month, he was arrested in Maine and indicted for conspiracy; he is currently free on bail.

Another contractor, bodyguard Don Ayala, is also out on bail after being indicted for a murder committed in Afghanistan last month. According to a military affidavit, Ayala shot Abdul Salam at close range in the head after Salam doused his colleague, social scientist Paula Lloyd, with petrol and set her on fire. Lloyd had approached Salam on the street — he was carrying a fuel jar — to ask him about the price of petrol.

Lloyd returned to the United States to recover from her burns; some of her colleagues have not been so lucky. Social scientist Michael Bhatia was killed in Afghanistan in May; Nicole Suveges, a PhD student from Johns Hopkins University in Baltimore, Maryland, died in Iraq the following month.

Their names and sacrifices should be remembered. But the programme that employed them should not — except, perhaps, as an example of yet another good idea gone wrong on the war fields of Iraq and Afghanistan.

The immediate problems with the Human Terrain System can be traced to BAE Systems, the military contractor based in Rockville, Maryland, that screens potential employees, then trains those it hires. It has failed in every one of those functions, and army management has failed in its oversight of BAE.

But the larger question is whether the Human Terrain System is viable at all. *Nature* is not opposed in principle to academics working with the military; we have said before that social science can and should inform military policy (see *Nature* **454,** 138; 2008). We continue to believe that the insights of science have much to offer strategies in a war zone — not least through training combat troops to understand the local cultures within which they operate.

But as currently constituted, the Human Terrain System is not the way to do this. Unless the programme can be reborn in a format less plagued by deadly mistakes, it needs to be closed down. ■